IPEX-2 Post Flight Ground Test

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for
MICRODYNAMICS WORKSHOP
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Discussion

- Purpose of the Post Flight Ground Tests
- Test Configuration
- 1- Bay Ground Test
- 9-Bay Truss Ground Test
- Conclusions

Purpose of the Ground Tests: *What Can We Learn About Microdynamics Through Modal Testing*

Address Post Flight Verification for Truss

- Attempt to duplicate on orbit flight data by introducing low level vibration source.

Model Correlation

- Burst Random and produced modal characteristics for finite element model correlation.

Linearity Check

- Ascending and Descending Stepped-Sine tests address global linearity of the truss.

Instrument Verification

- Collocated test and flight accelerometers for flight electronics calibration during tests.

Microdynamics

- Provided opportunity to investigate structural snapping by obtaining time histories from thermal loading.

Component Level Testing

- Characterized 1- bay structural dynamics as compared to 9-Bay truss.

Test Configuration for 1- Bay and 9-Bay Truss

Signal Processing and Data Acquisition System:

- Utilized IDEAS software for signal processing and analysis
- 64 channel HP VXI for data acquisition

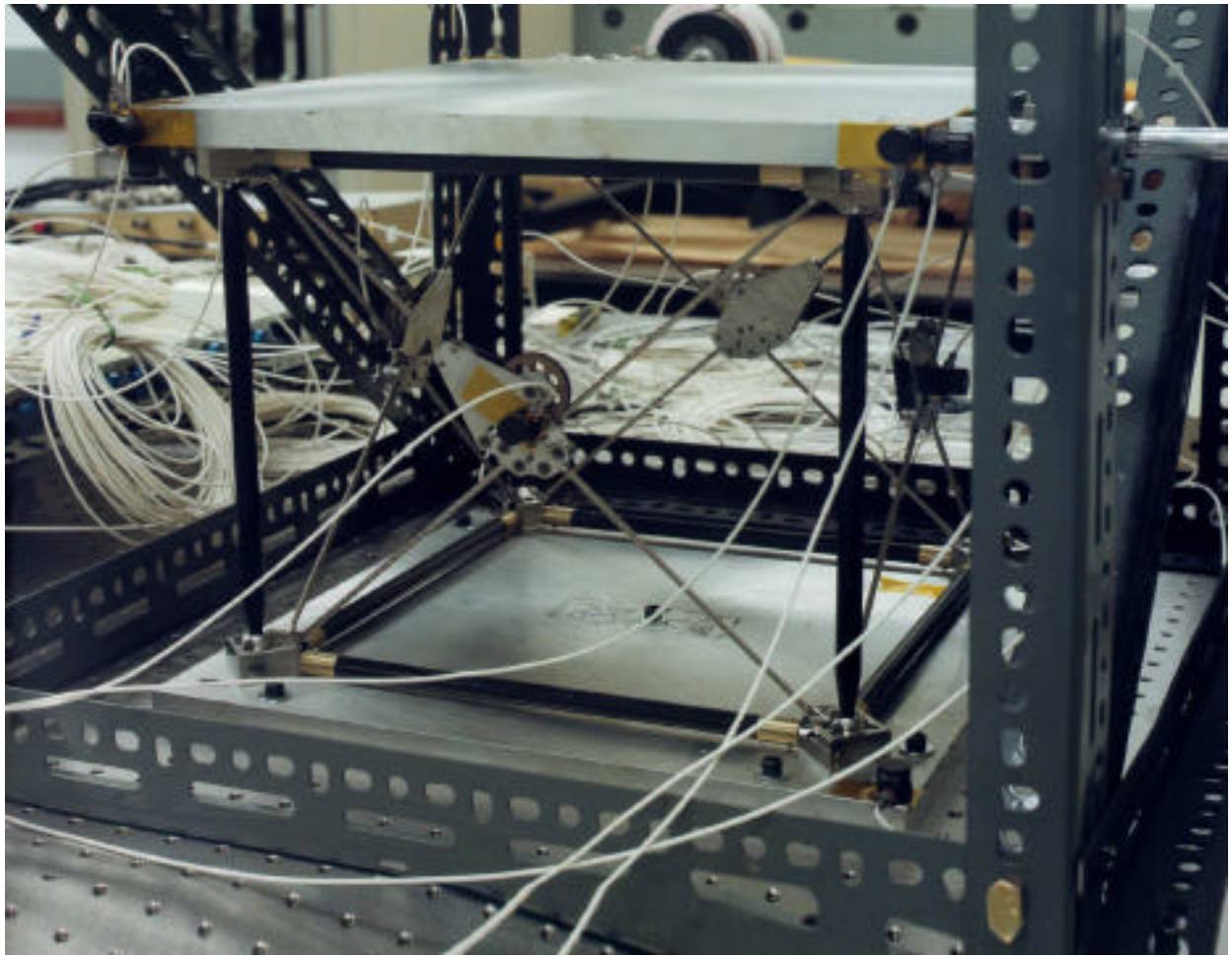
Excitation System:

- Structure excitation was provided by two 5 lb electro-static shakers

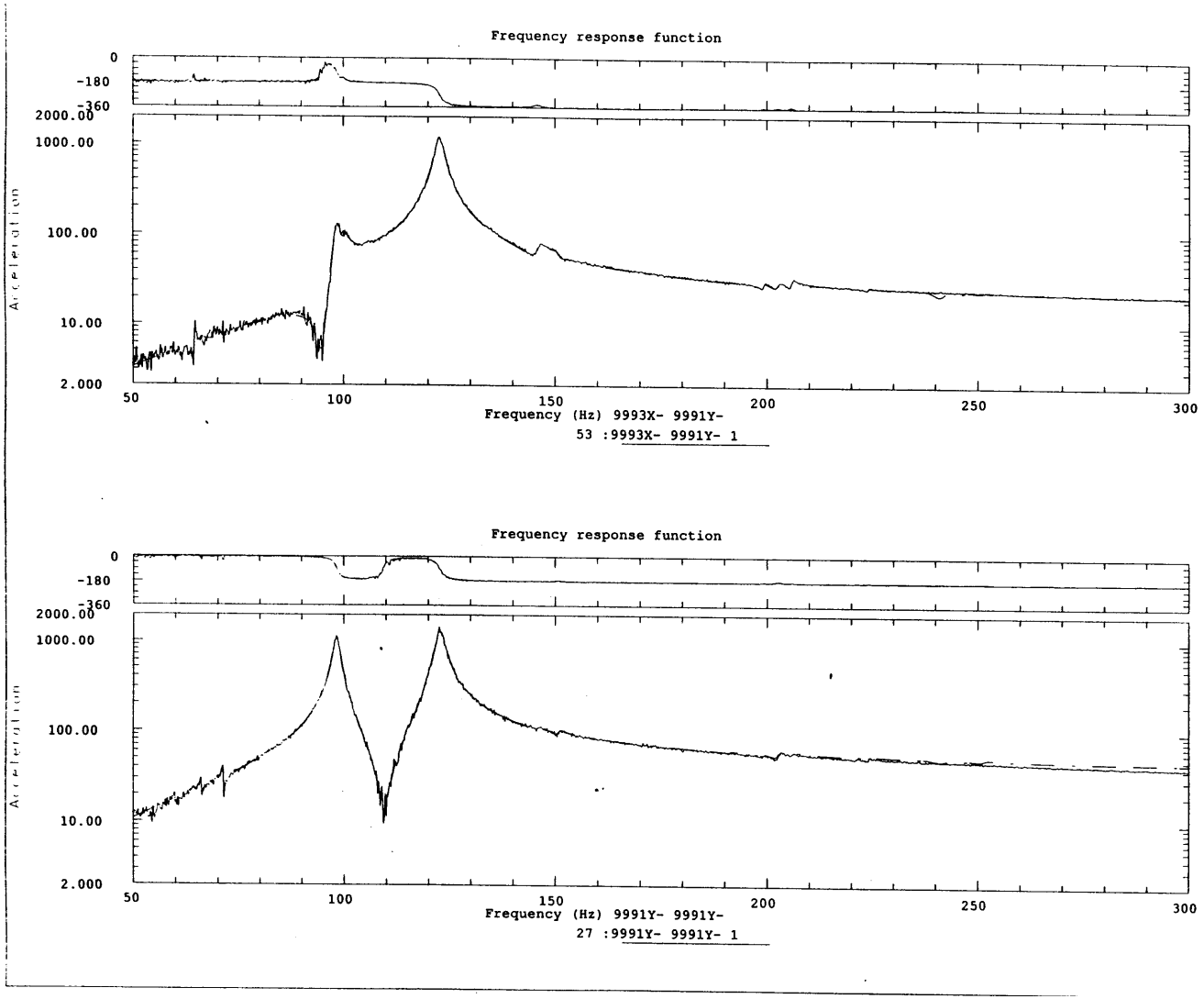
Accelerometers:

- Single Bay was instrumented to measure 27 degrees of freedom
- Truss was instrumented to measure 60 degrees of freedom

1-Bay Test Configuration



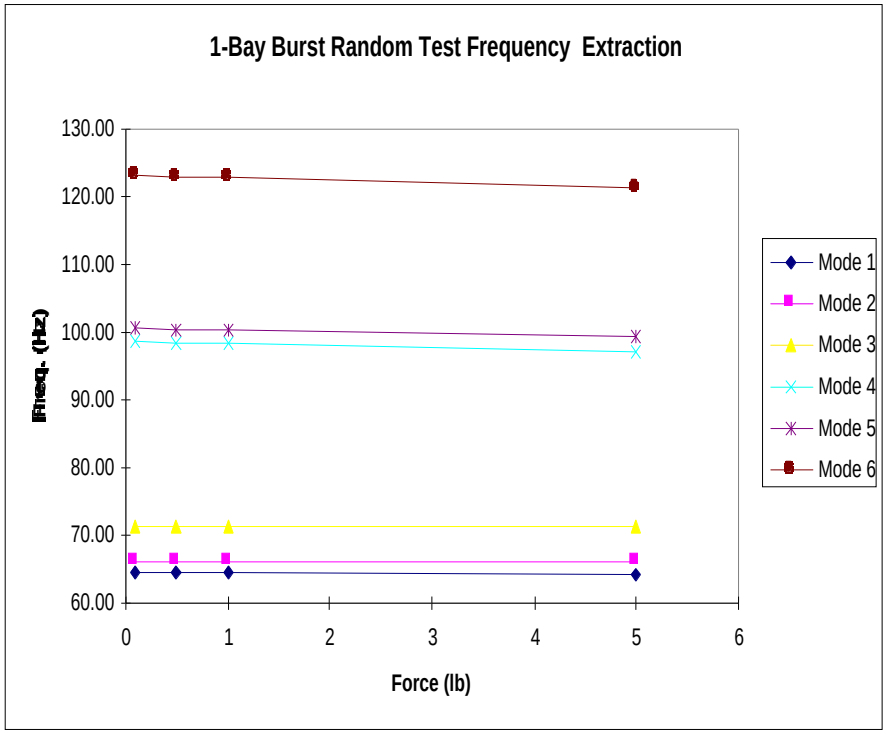
1-Bay Data Curve Fit



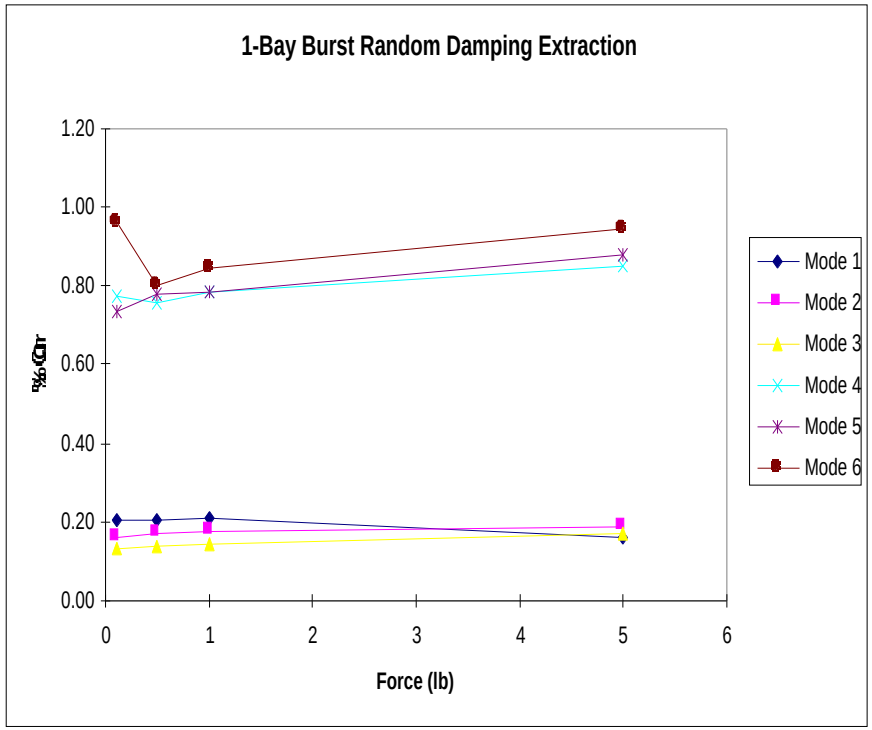
1-Bay Mode Description

Mode Shape Description for 1-Bay Burst Random Tests			
Mode	Freq. (Hz)	Damp (%)	Mode Shape Description
1	64.5	0.2	Breathing Mode
2	66.1	0.2	Breathing Mode
3	71.3	0.1	Breathing Mode
4	98.3	0.8	1st Bending Mode
5	100.2	0.8	2nd Bending Mode
6	122.8	0.8	Torsion Mode

1-Bay Burst Random Test
Modal Properties vs. Force Input



Modal Frequency

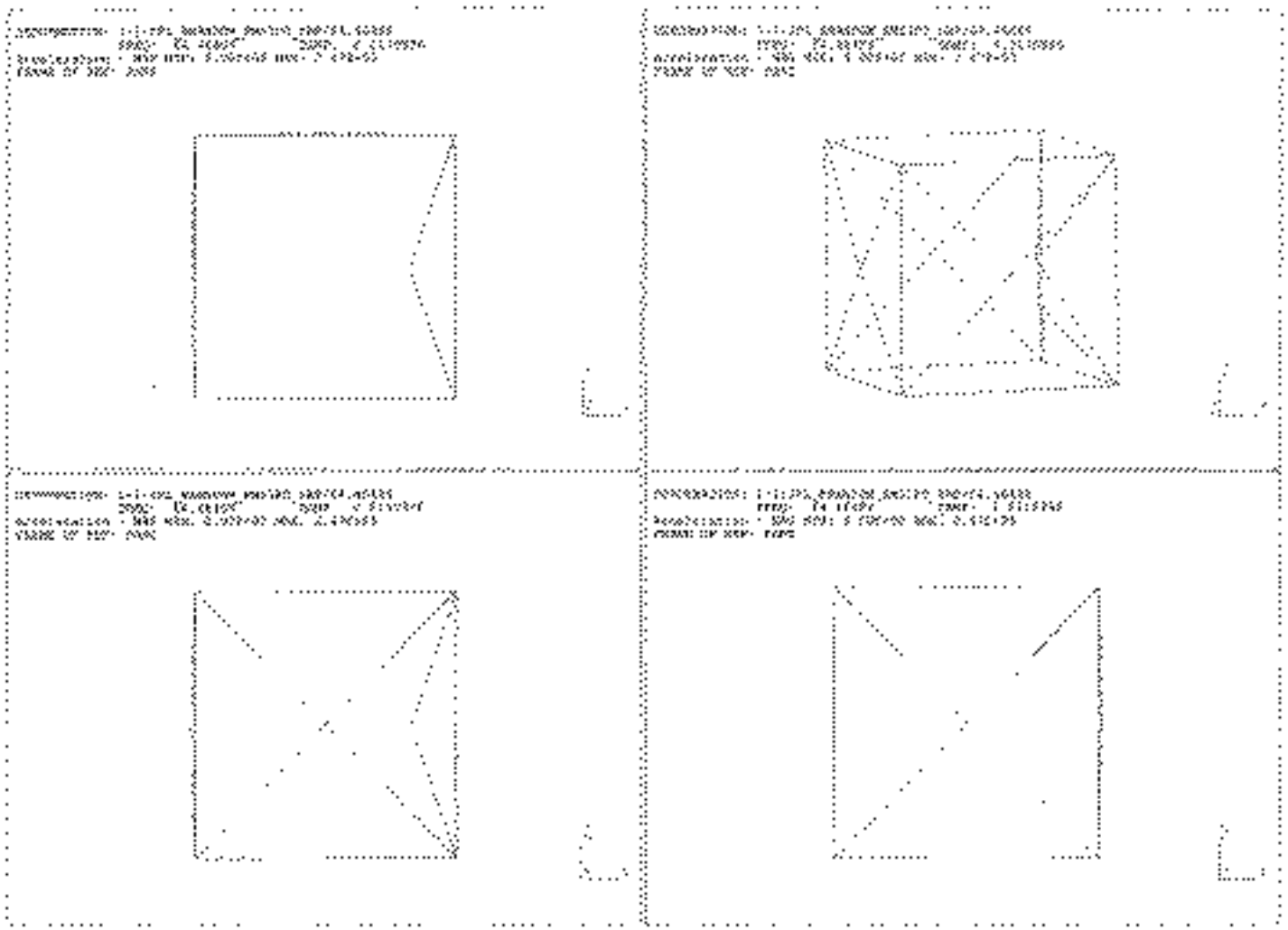


Modal Damping

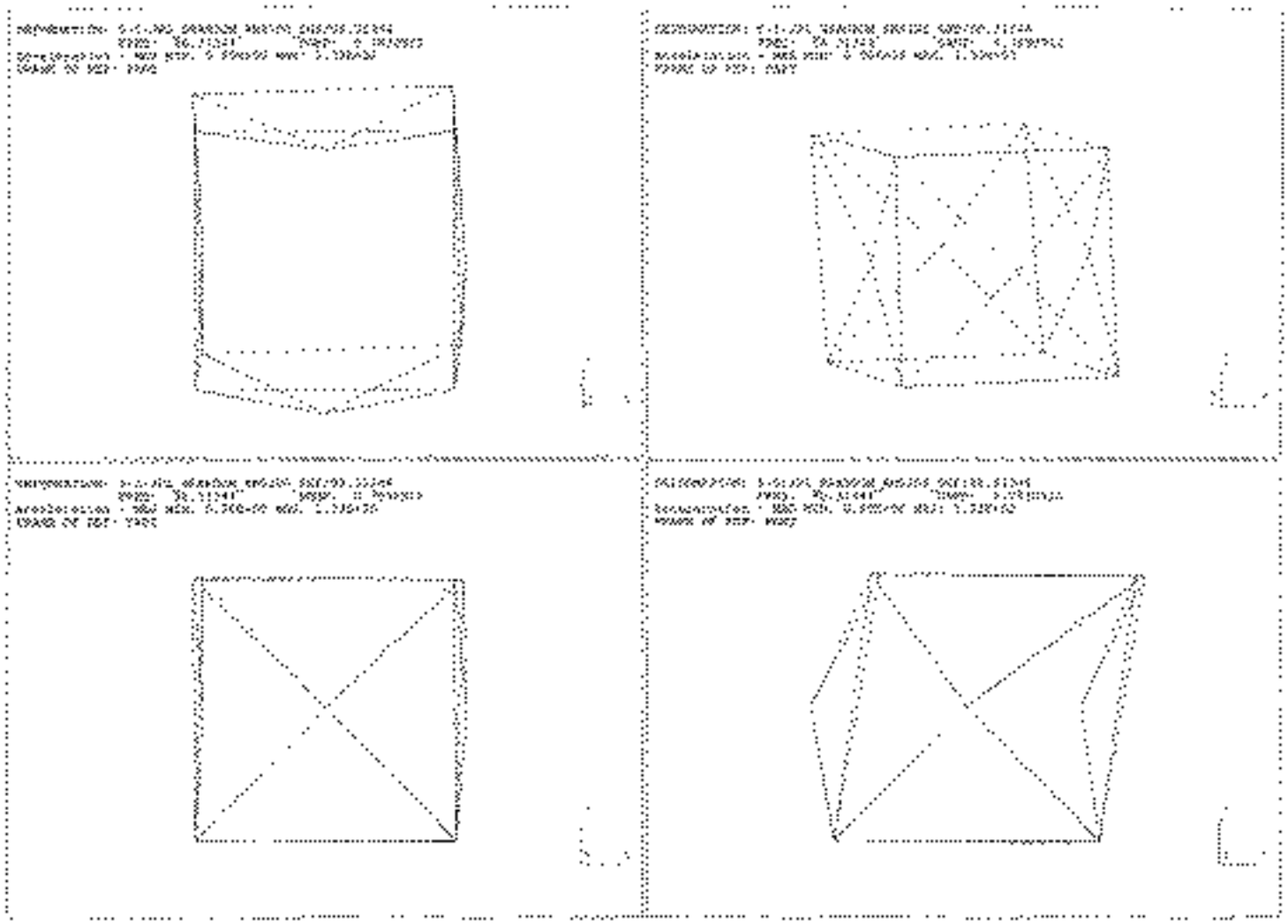
1-Bay Stepped-Sine Test

Curve Fit Results from 1-Bay Stepped-Sine Test			
Mode	Freq.(Hz)	Damp(%)	Mode Shape Description
1	64.2	0.2	Breathing Mode
2	67.4	0.4	Breathing Mode
3	71.4	0.1	Breathing Mode
4	98.5	1.4	1st Bending Mode
5	100.8	1.4	2nd Bending Mode
6	123.6	1.3	Torsion Mode

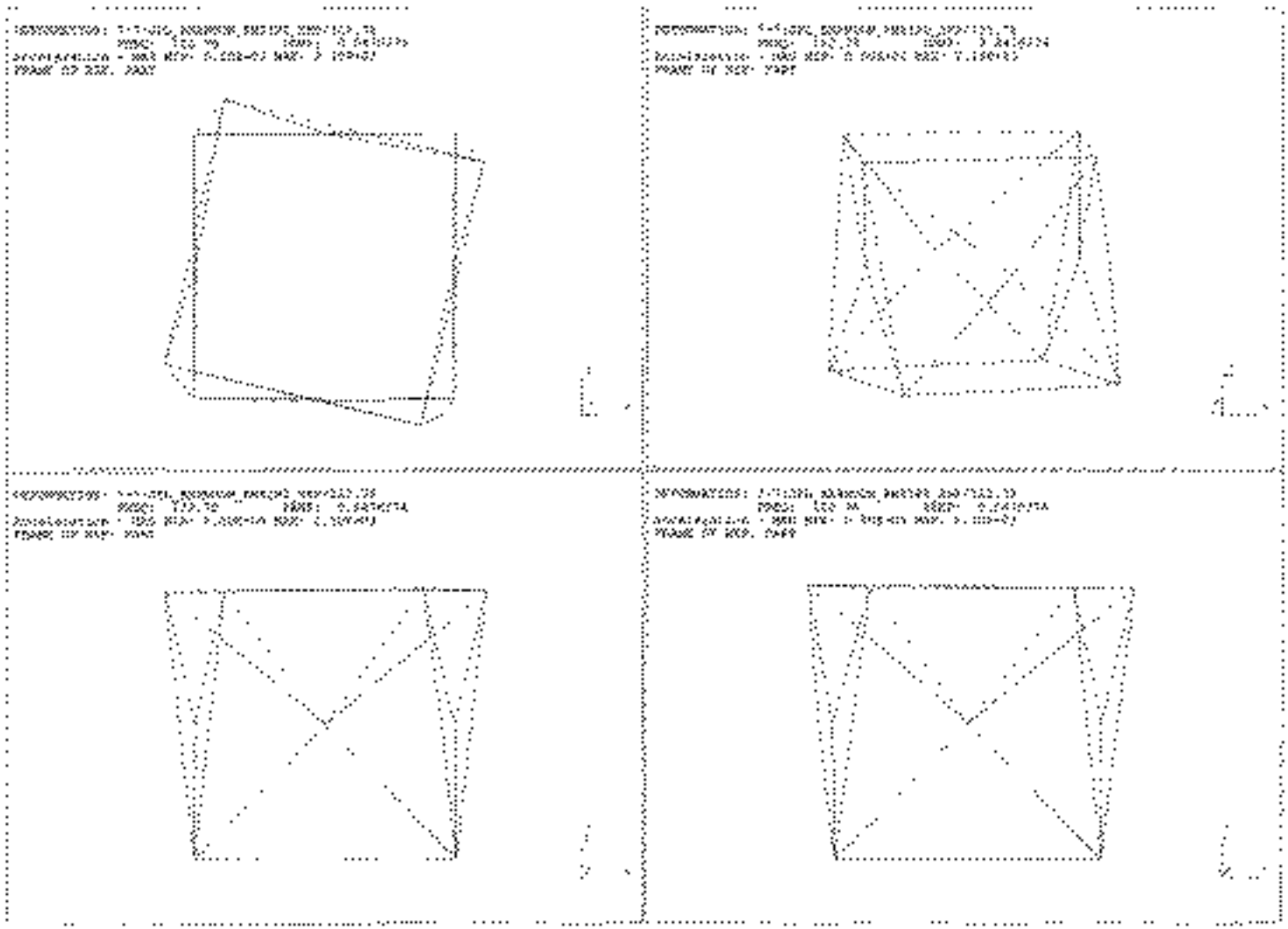
1-Bay 1st Breathing Mode at 64.5 Hz



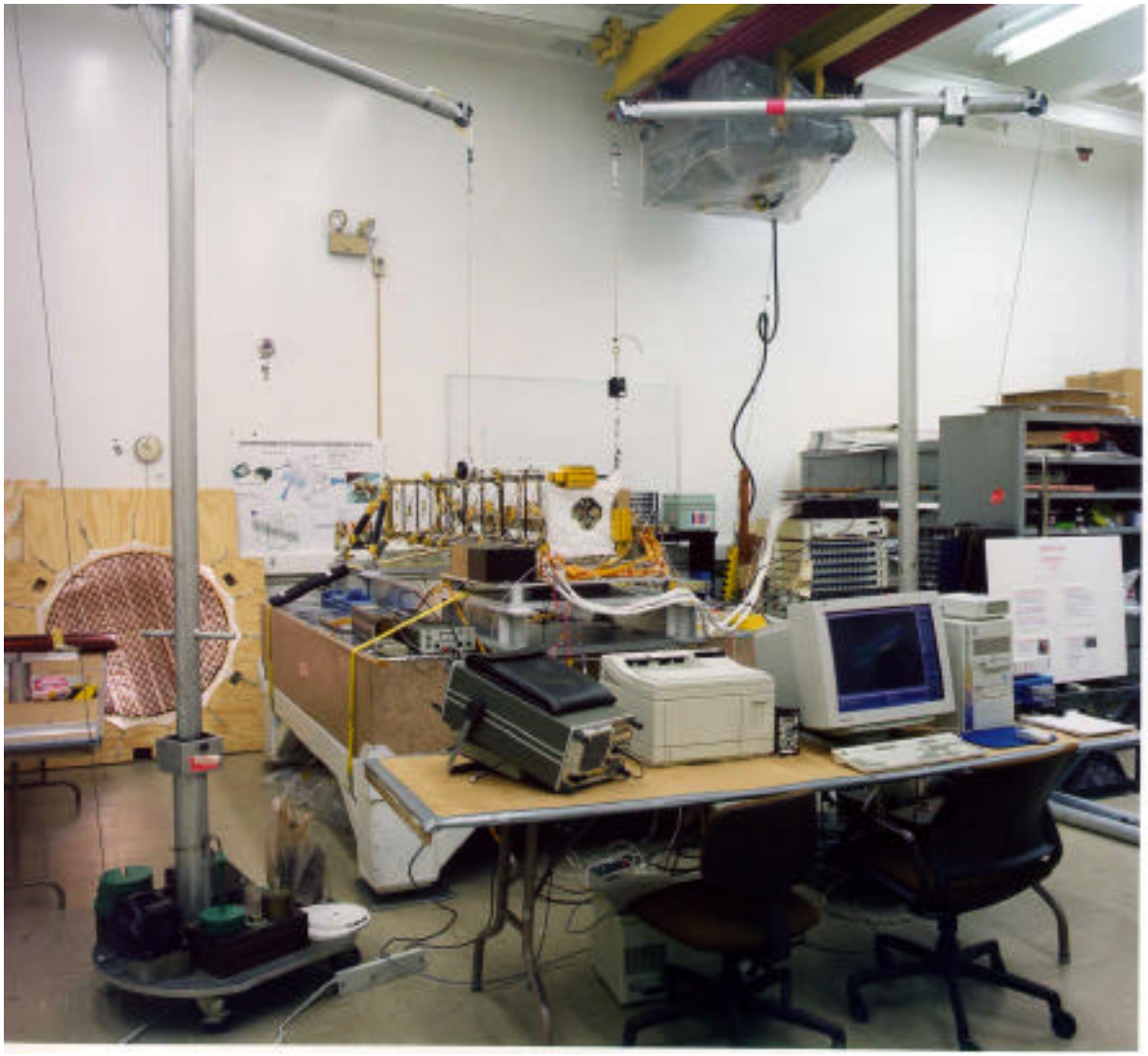
1-Bay 1st Bending Mode at 98.3 Hz



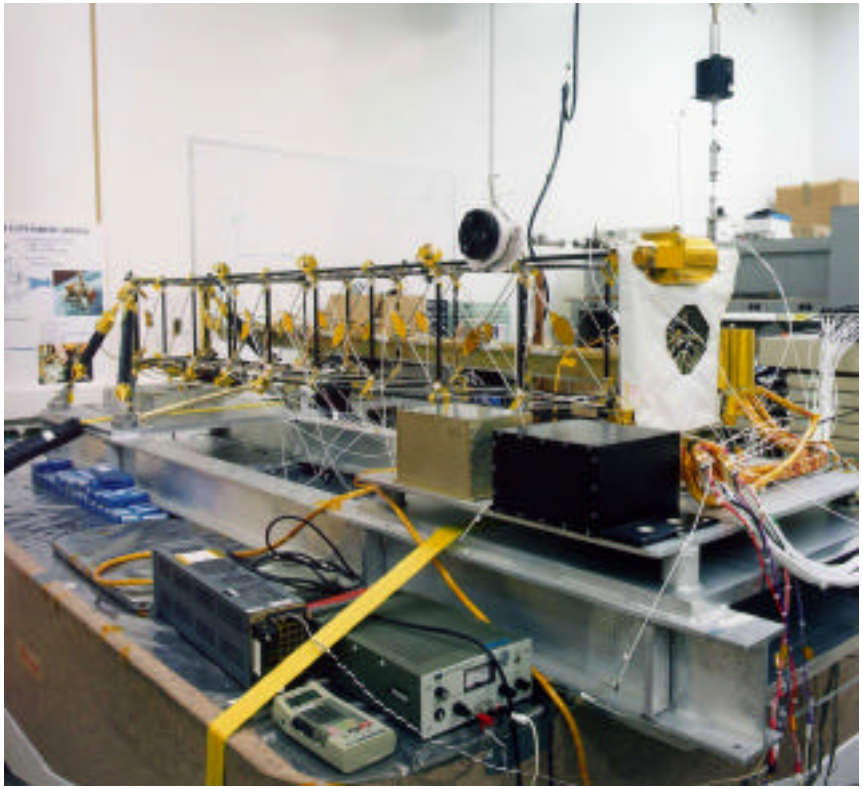
1-Bay Torsion Mode at 122.8 Hz

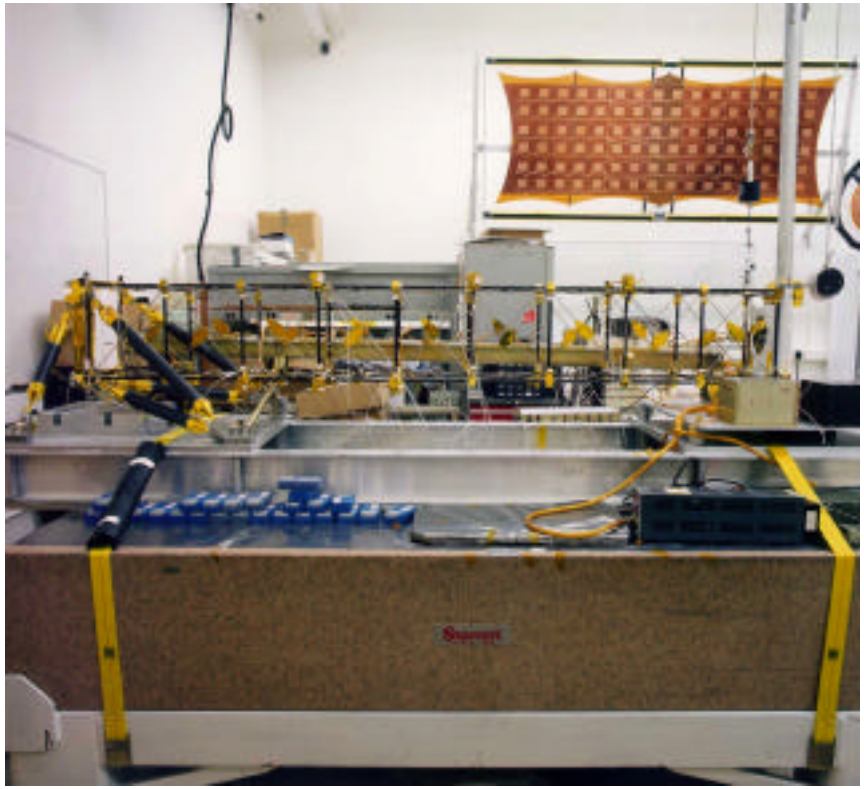


9-Bay Truss Test Configuration



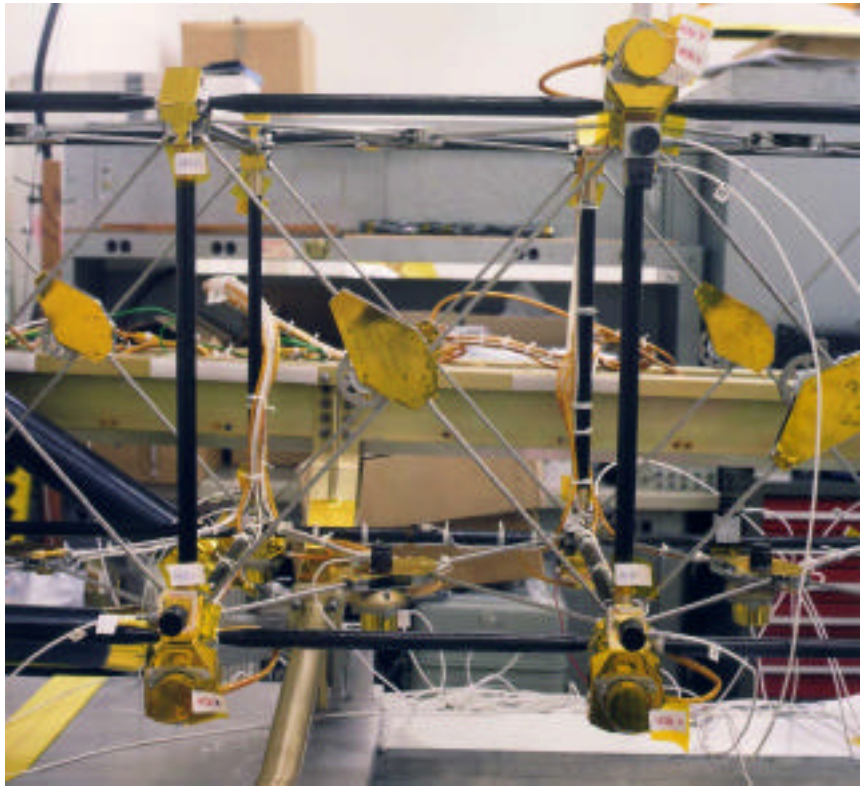
9-Bay Truss Overview

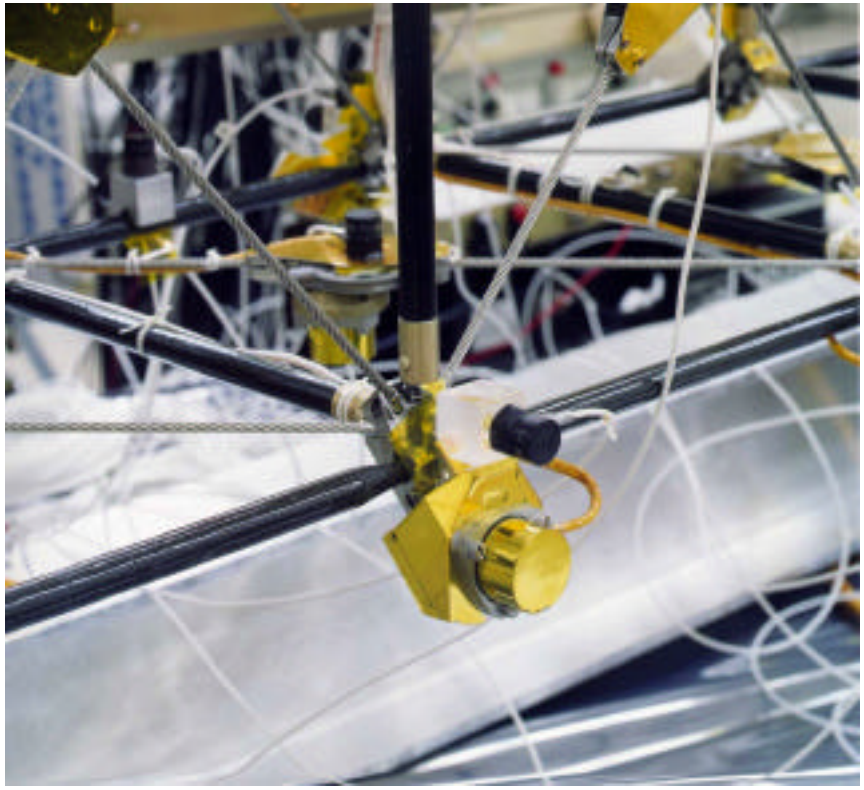




9-Bay Truss Support Struts

Bay Configuration





9-Bay Truss Mode Description

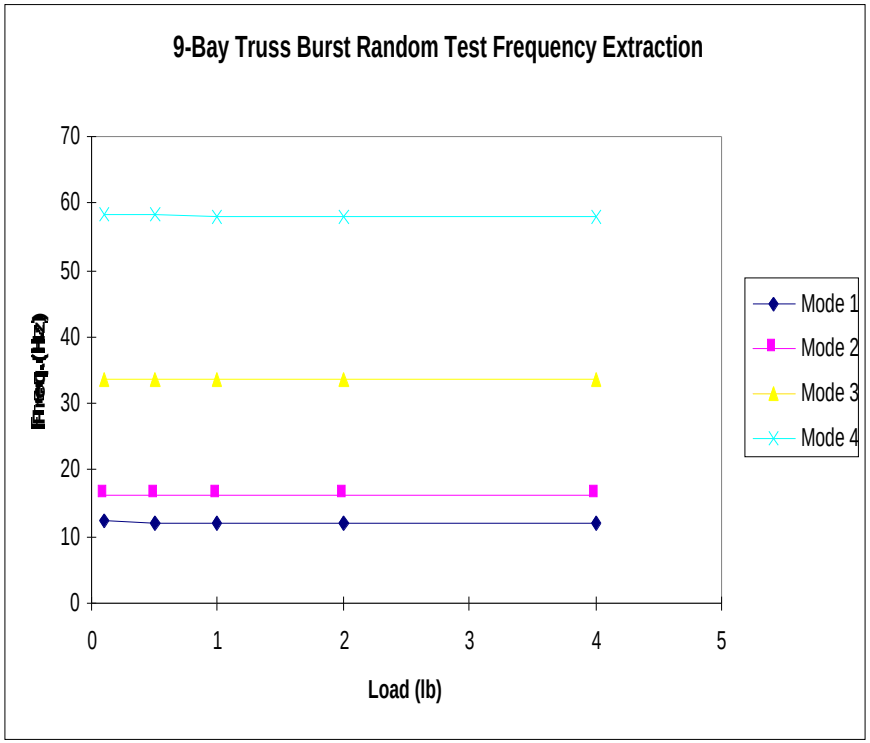
Description of Truss Modal Test Modes

Mode	Freq (Hz)	Damp (%)	Mode Shape Description
1	12.15	0.94	Transverse Shearing
2	16.31	1.00	Transverse Shearing
3	33.63	0.82	Torsion
4	58.18	0.14	Breathing Mode (Fitting)

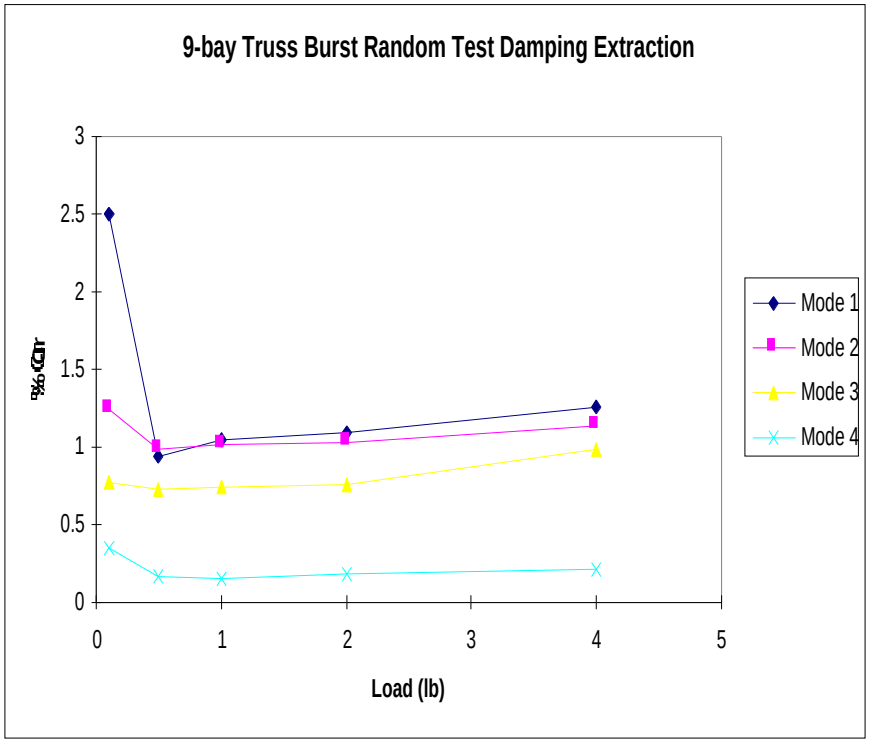
Modal Comparisons

Mode #	Test Freq. (Hz)	FEM Freq. (Hz)	On Orbit Freq. (Hz.)	Mode shape
1	12.15	16.30	-	Shear
2	16.31	19.90	19.90	Shear
3	33.63	29.78	37.92	Torsion
4	58.18	54.70	64.91	Breathing (fitting)

9-Bay Truss Burst Random Test
Modal Properties vs. Force Input

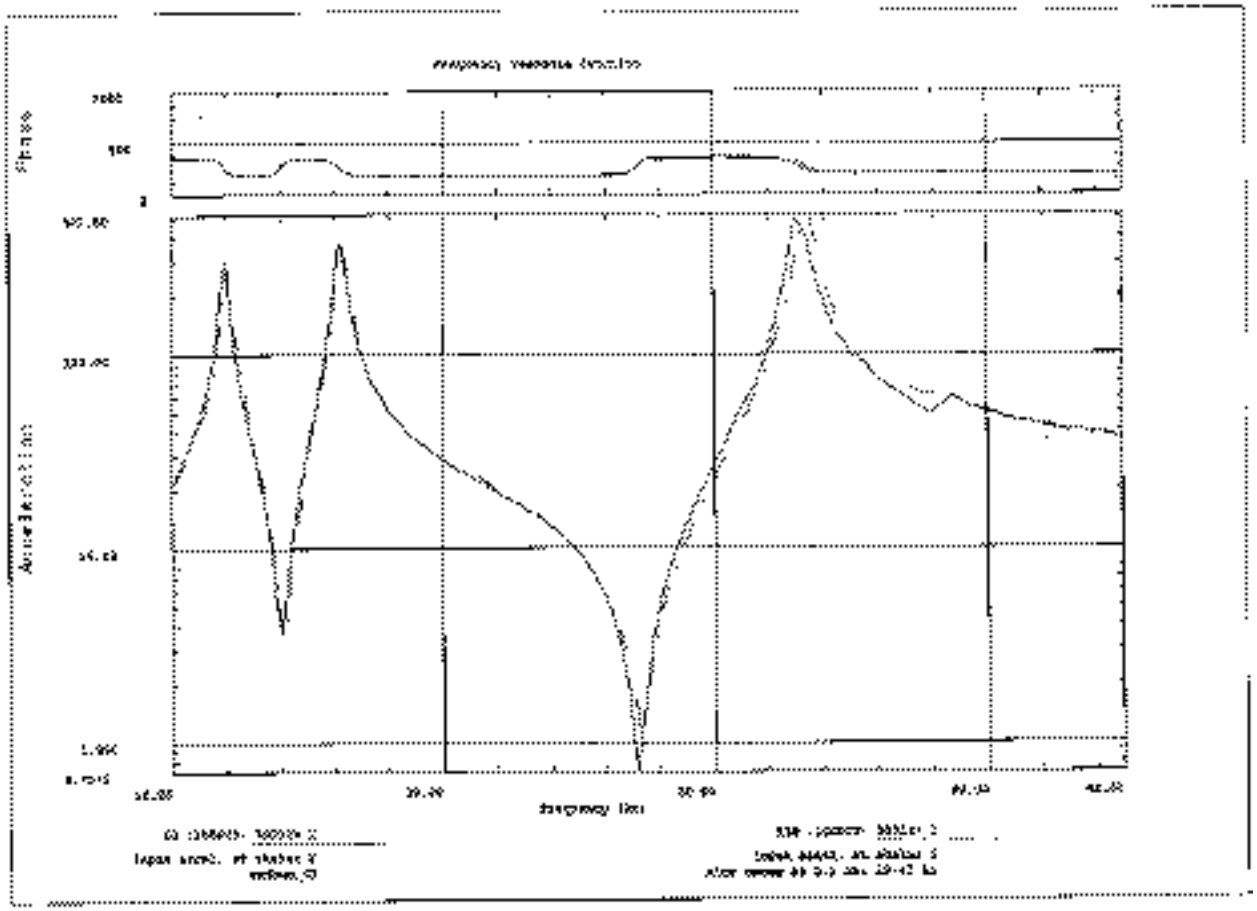


Modal Frequency

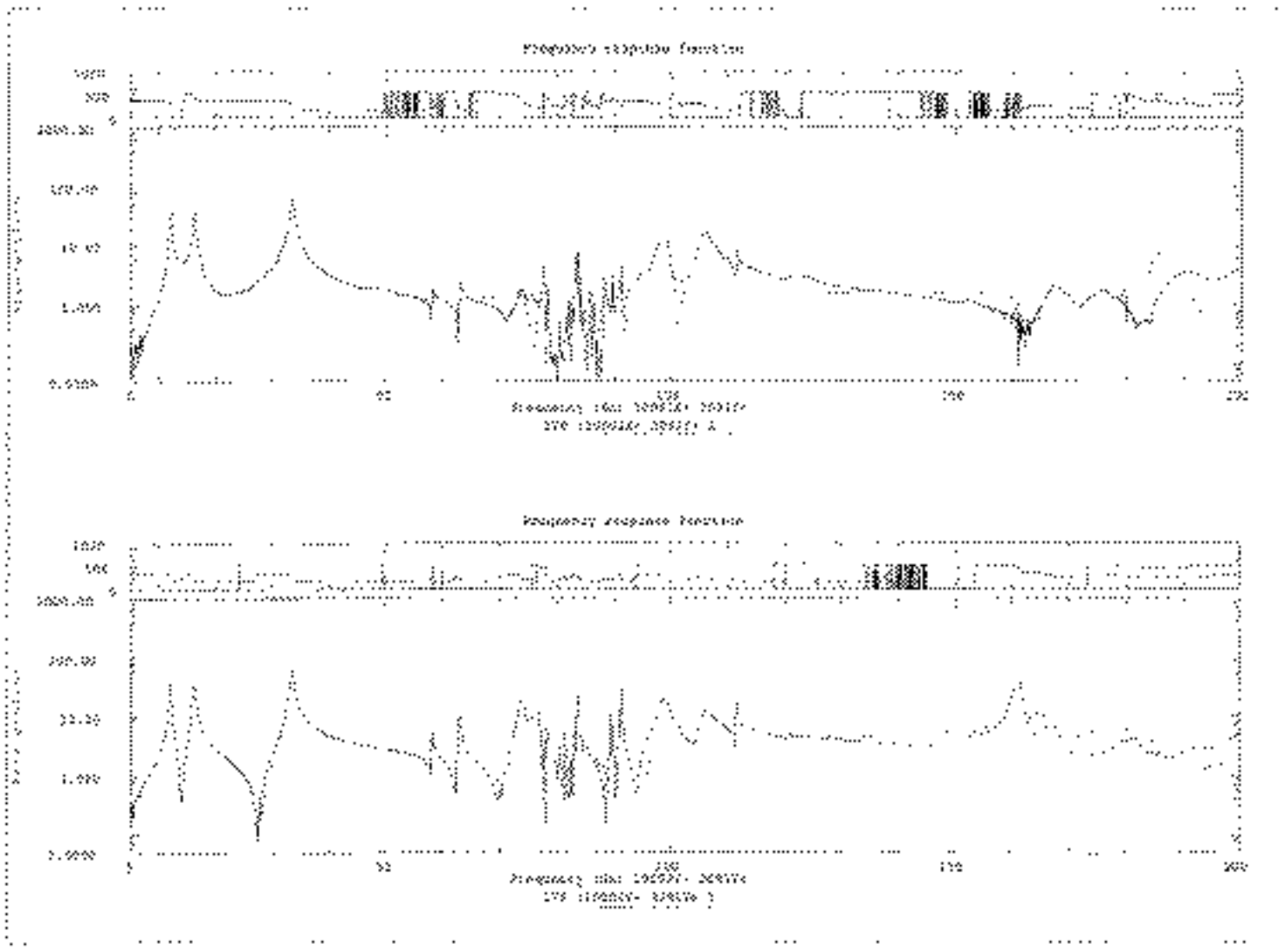


Modal Damping

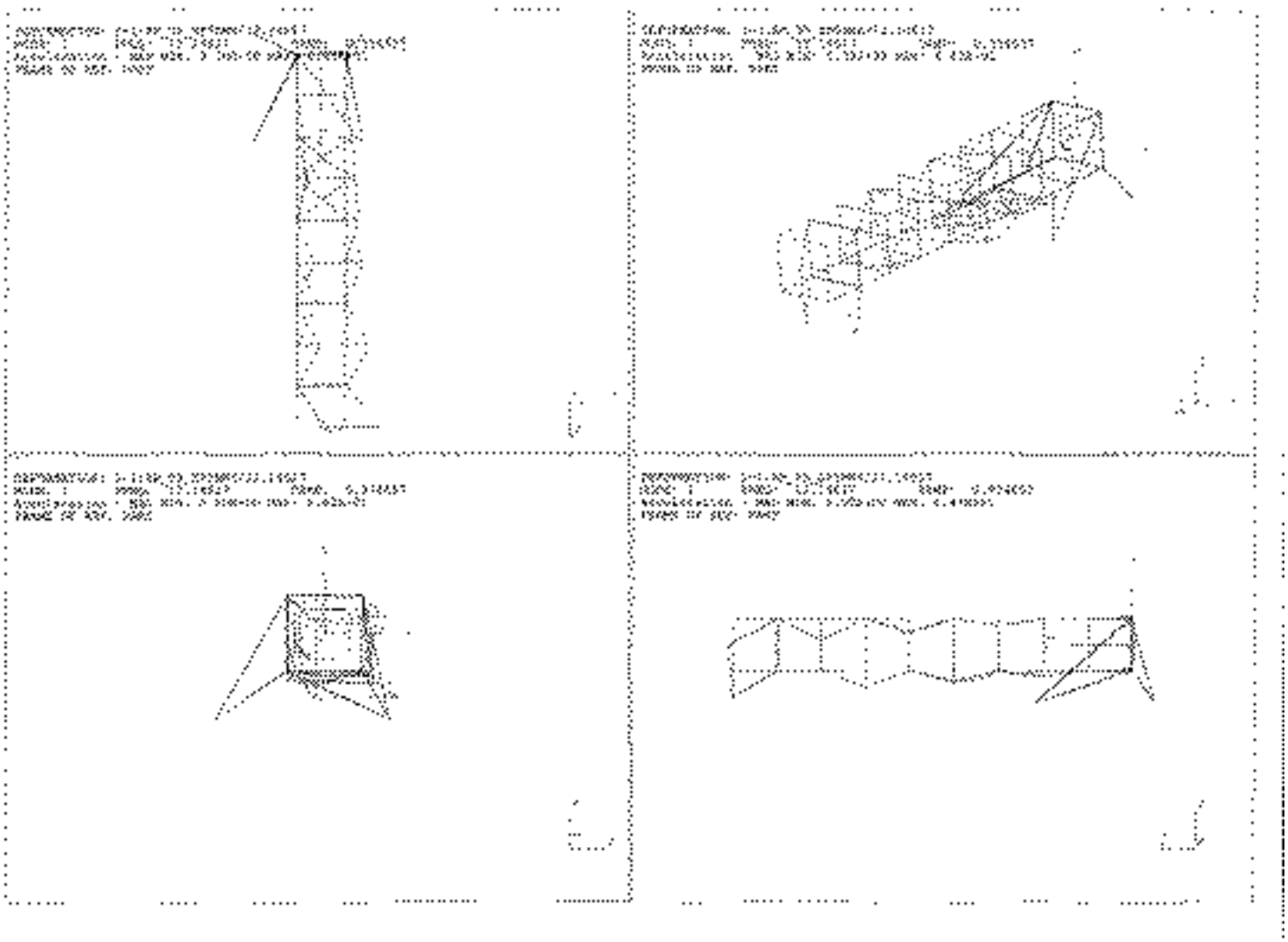
9-Bay Truss Stepped Up vs. Stepped Down



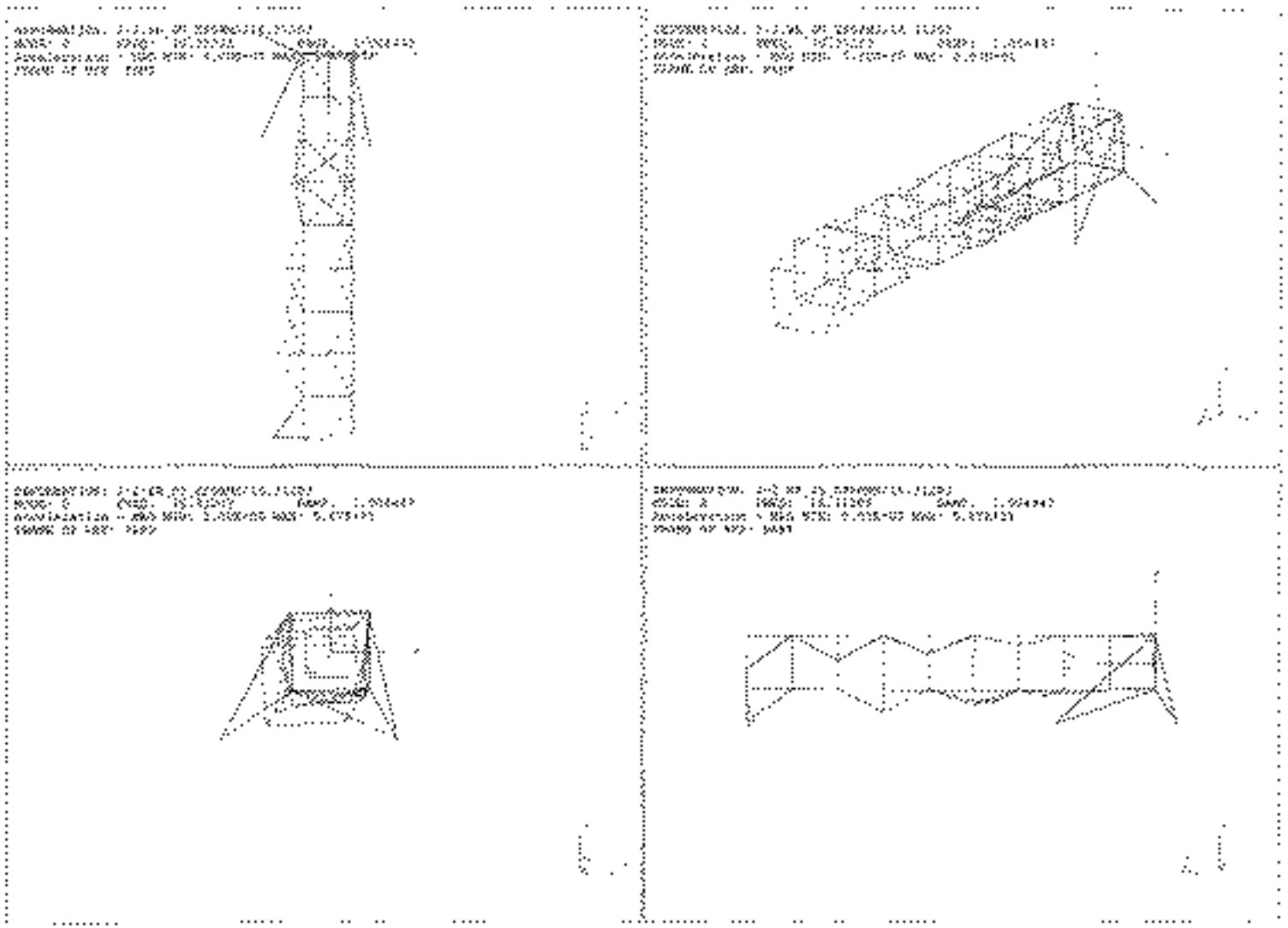
9-Bay Truss Data Curve Fit



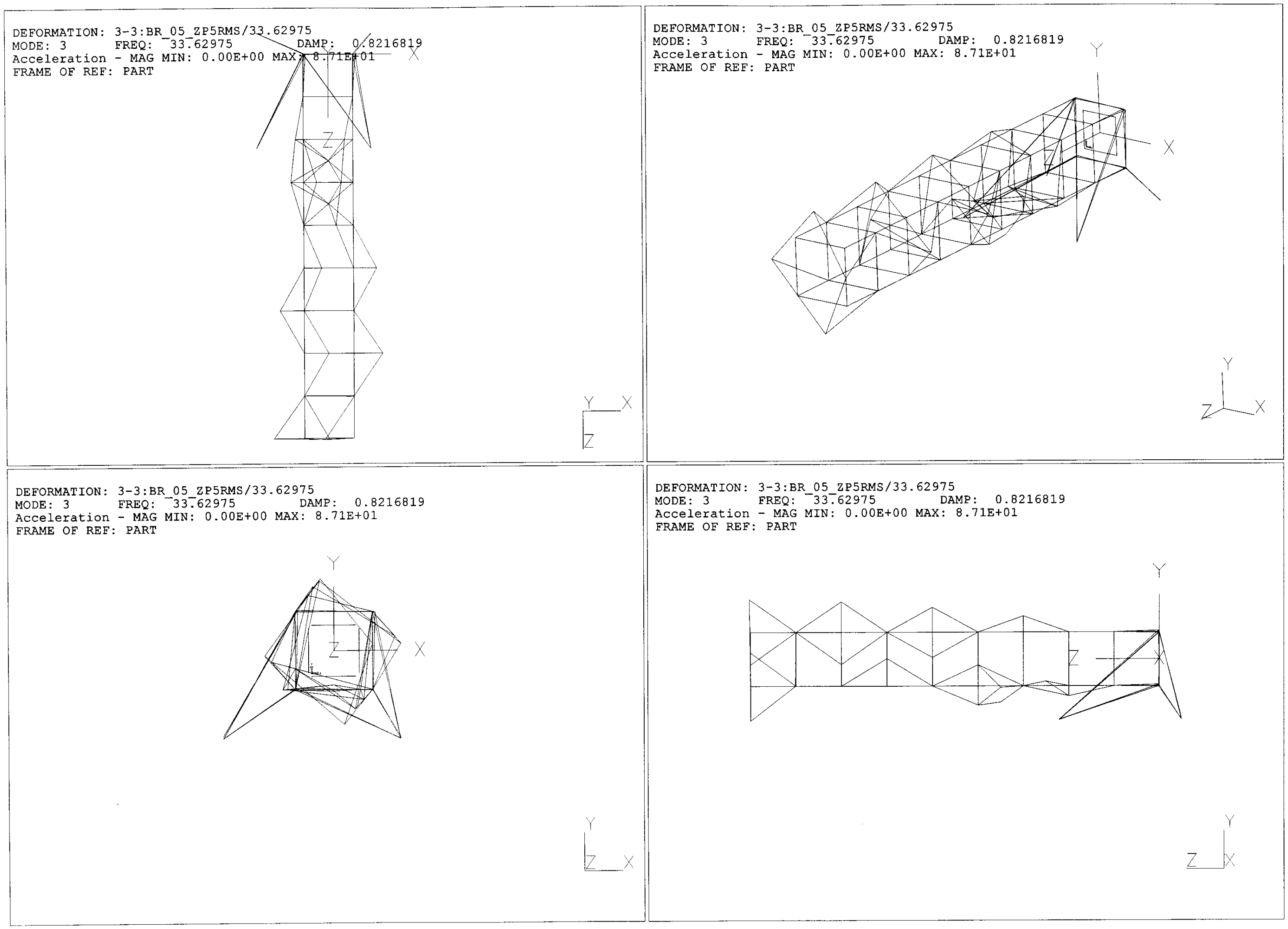
9-Bay Truss 1st Bending Mode at 12.1 Hz



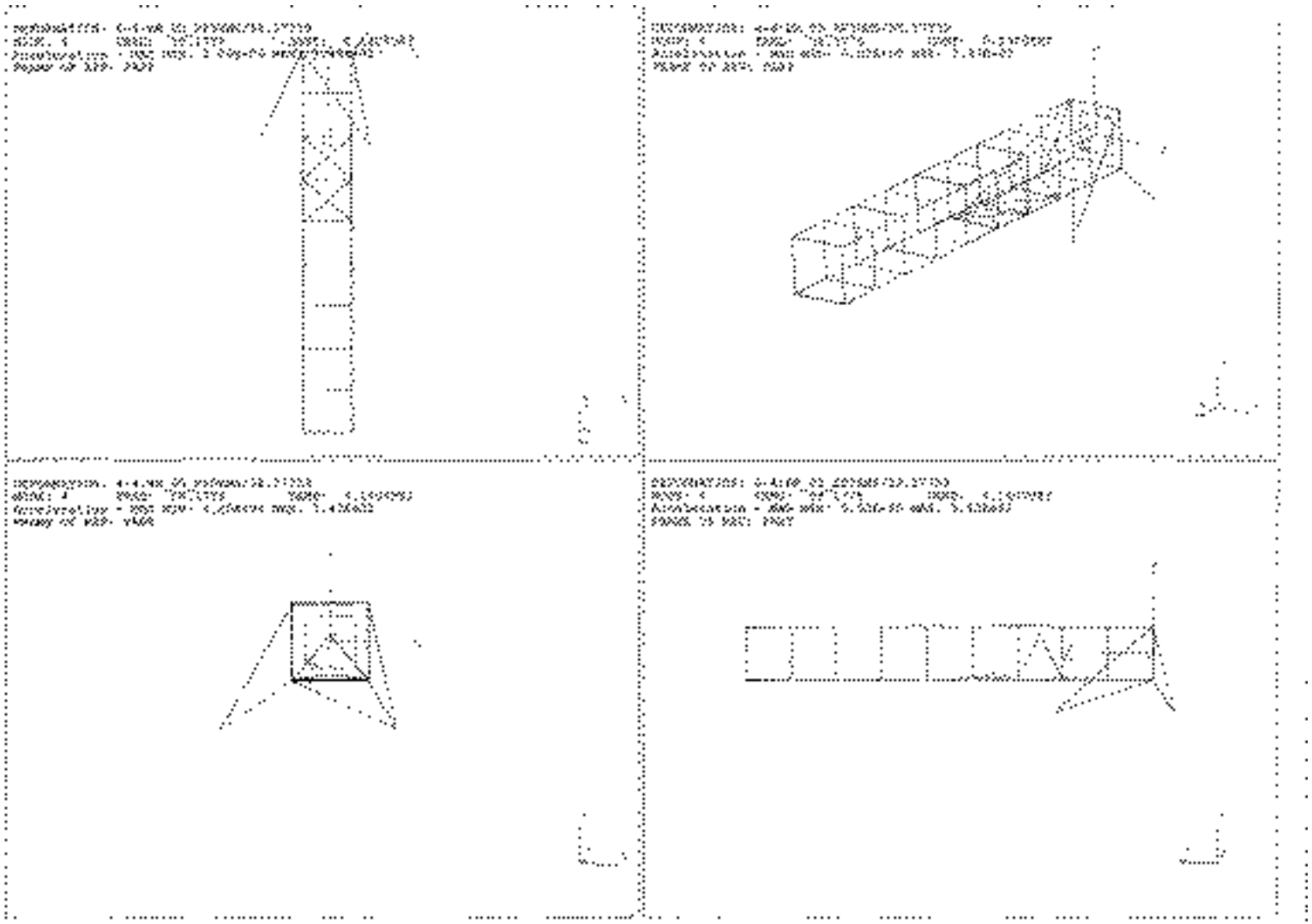
9-Bay Truss 2nd Bending Mode at 16.3 Hz



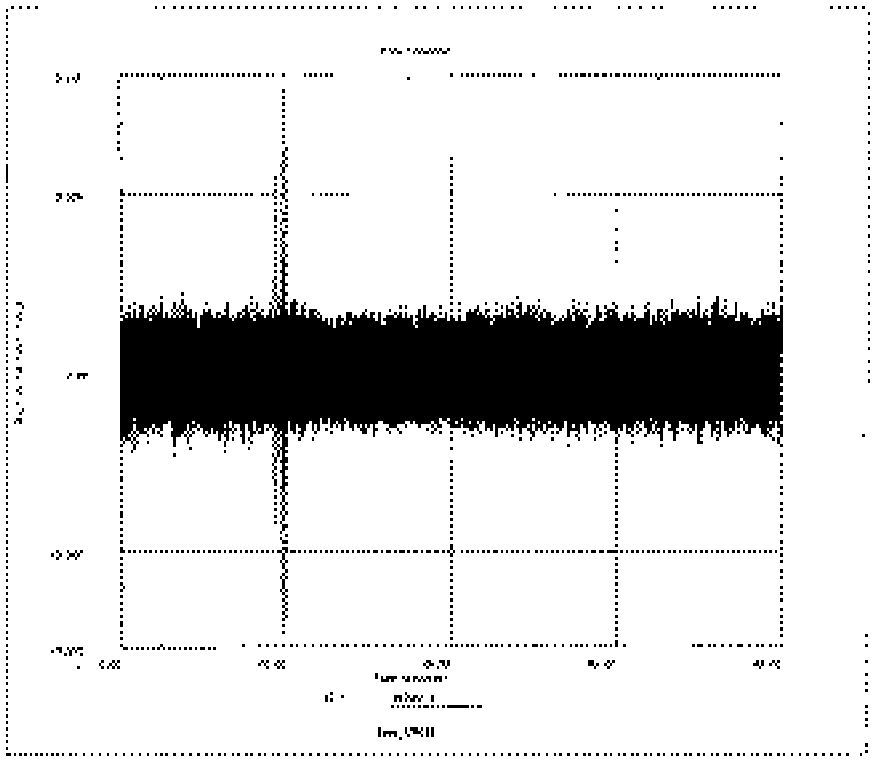
9-Bay Truss Torsion Mode at 33.6 Hz

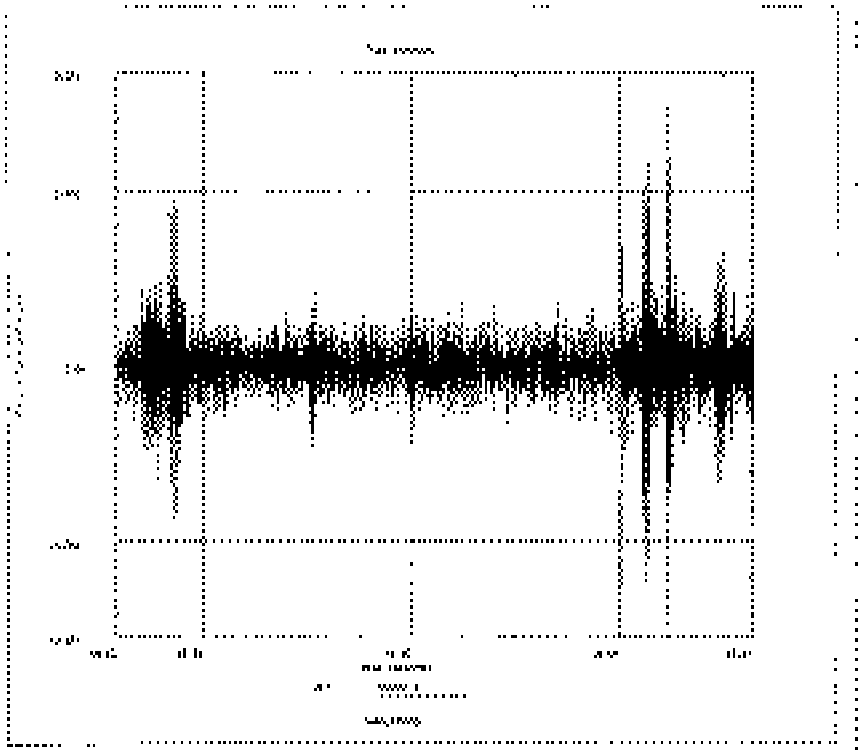


9-Bay 1st Breathing Mode at 58.2 Hz

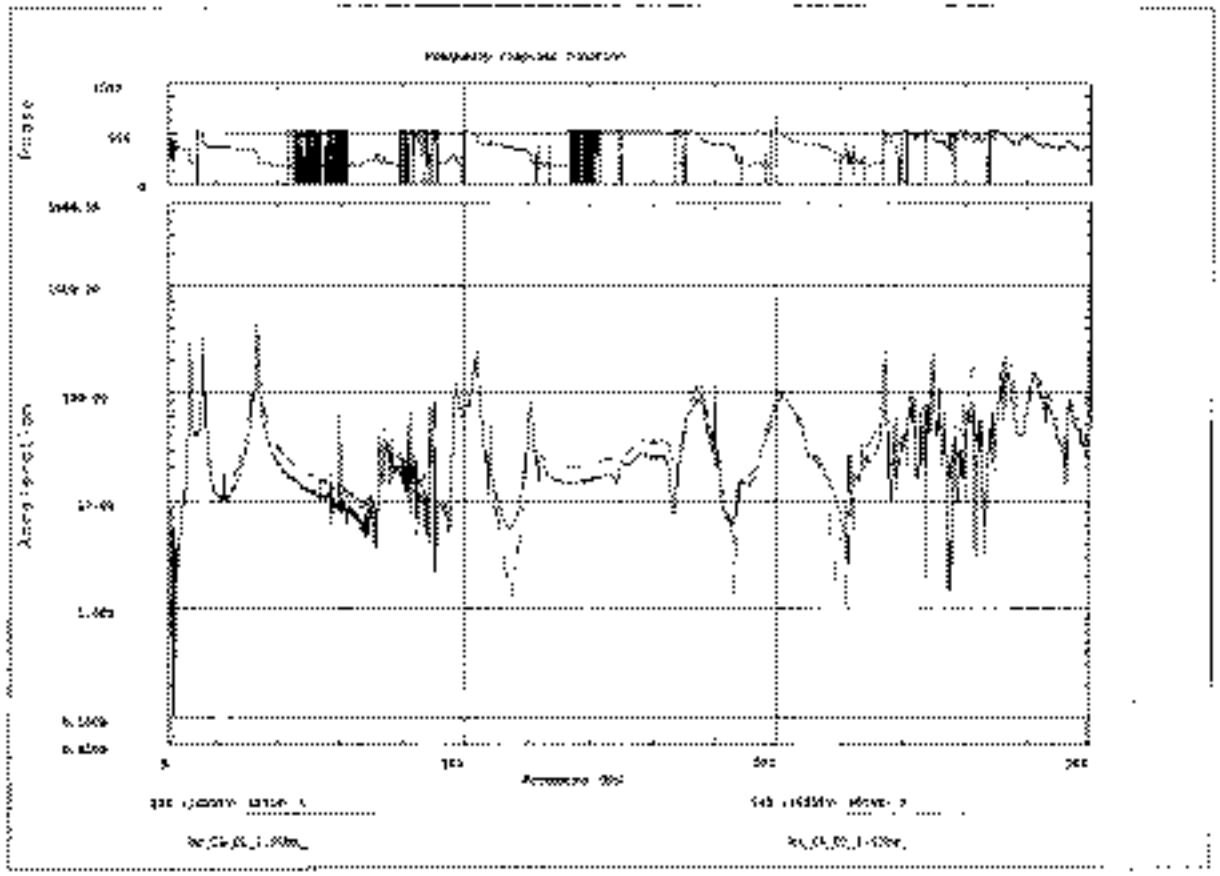


9-Bay Truss Thermal Snapping





9-Bay Truss
Collocated Flight and Test Accelerometers



Conclusions:
Quantification of Microdynamic Behavior

- As input level increases, modal frequencies decrease as modal damping increases; structure appears to become softer due to slipping joints.
- Stepped Sine tests indicated both the 1-bay structure and 9-bay truss are highly linear at low force levels.
- Thermal loading produced structural snapping.
- It was verified that flight instrumentation was reliable based on calibration tests.
- Due to dissimilar boundary conditions, modes from test are lower compared to on orbit and the finite element model predictions.